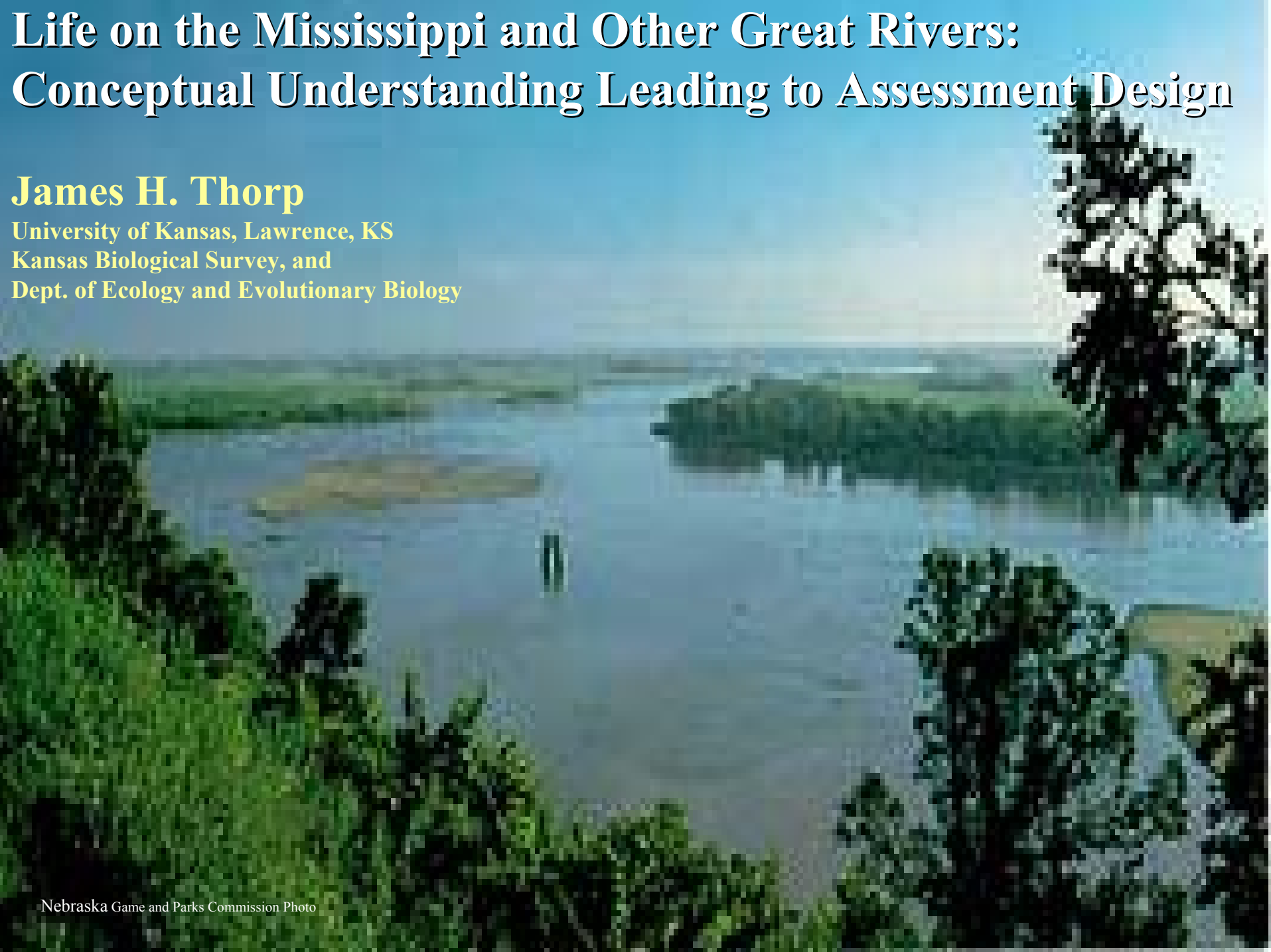


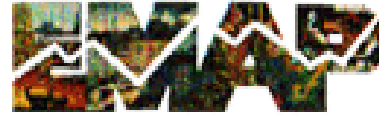
US EPA ARCHIVE DOCUMENT

# Life on the Mississippi and Other Great Rivers: Conceptual Understanding Leading to Assessment Design

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Kansas Biological Survey, and  
Dept. of Ecology and Evolutionary Biology





## **Environmental Monitoring and Assessment Program**

*A research program to develop environmental tools for monitoring and assessment*

### **EMAP's goal:**

**“... to develop the scientific understanding for translating environmental monitoring data from multiple spatial and temporal scales into *assessments of ecological condition* and *forecasts of the future risks to the sustainability* of our natural resources.”**

# **My objectives today are to:**

- 1. Define great rivers.**
- 2. Evaluate importance of river size from ecological, economic, and technique perspectives.**
- 3. Identify other important differences among and within great rivers.**
- 4. Consider other conceptual river issues relevant to EMAP.**

**These perspectives are influenced by my research experience in the Mississippi, Missouri, Ohio, Tennessee, and St. Lawrence Rivers.**



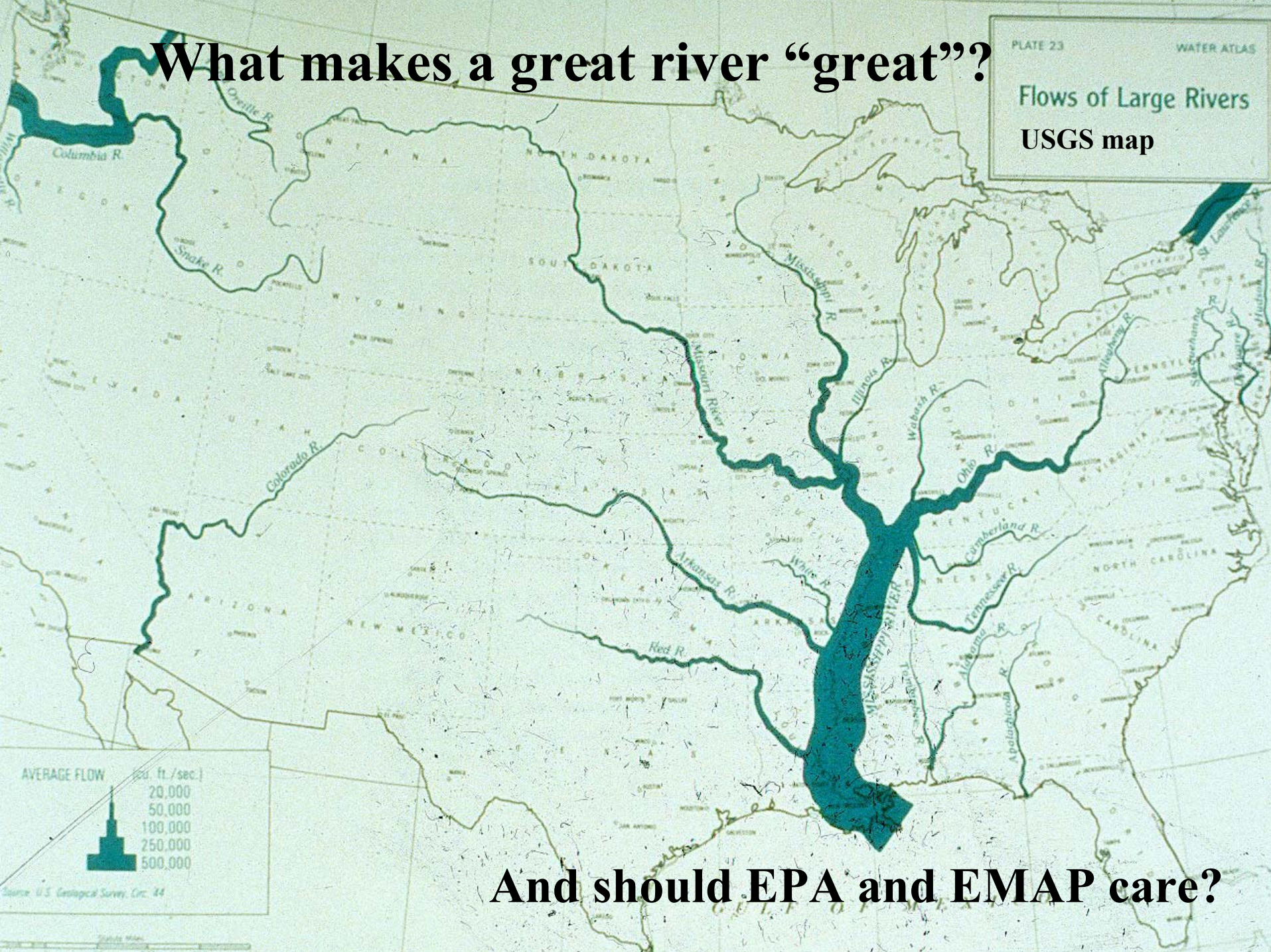
# What makes a great river “great”?

PLATE 23

WATER ATLAS

Flows of Large Rivers

USGS map



## And should EPA and EMAP care?



# River Size - A Continuous Variable With Categorical Labels



Great rivers are first and foremost “big rivers”!

Non-wadeable

7<sup>th</sup> order or larger

High discharge

... and large enough to be intimidating!

How do large rivers differ from great rivers ?

**Great rivers (in their modern, regulated state) are large enough to be commercially navigable through most of the year.**



# **If river size is a continuous variable, should EPA recognize river categories?**

**From a practical standpoint ...Yes ... because important differences associated with river size are related to:**

**ecology/environmental biology (ecosystem integrity)**

**economics (sustainable use of rivers)**

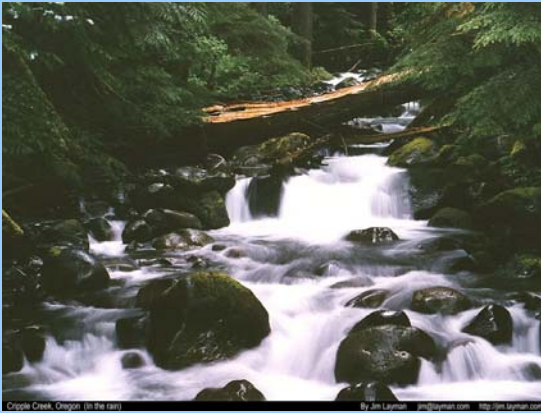
**monitoring and assessment approaches**

**for example ...**

- what economic & ecological indicators to focus on**
- how to sample these in different kinds of rivers**



# Ecological Justifications for Size Categories



**Oregon headwater stream**



**Amazon tributary**

**Width, depth, and discharge influence ecosystem structure and functioning by affecting processes at different levels:**

- **Species (life history strategies, morphology, behavior)**
- **Community - composition (e.g., functioning feeding groups, zooplankton)**
- **Community/ecosystem - food webs (nutrient sources, regulation)**
- **Ecosystem (e.g., productivity, nutrient spiraling)**

**Such differences influence EMAP's choice of:**

- **Ecological indicators**
- **Spatial and temporal scales for monitoring**
- **Sampling devices**

**\* And remember, the larger the river, the greater its integrative role !**

# Economic Perspectives on River Size



All sizes of rivers potentially provide humans with water, hydroelectric power, and recreational opportunities.

But, only great rivers can commercially support transport of coal, grain, and fertilizers.... a justification for a great river focus !

# River Size: Implications for Logistics and Study Techniques

**Target species change with the size and type of lotic ecosystem studied and which habitat is sampled.**

## Some Species in Wadeable Streams

**Topeka shiner**



**Fishfly eating  
a stonefly**

Photo by Larry Sherpa



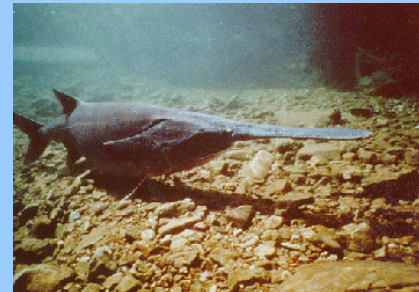
**Crayfish**

Photo by Bo DiStefano



## Some Species in Large and Great Rivers

**Paddlefish**



**True midge**

Photo by Dave Penrose



**Bosminid water flea**





# **River Size: Implications for Logistics and Study Techniques**



**Wading in streams, using a kick net, and adding chemical tracers are often not viable research and monitoring options in great rivers.**

# River Size: Implications for Logistics and Study Techniques



**25' Boston Whaler Challenger like the one we have at KU for large-great river research**

**Studies in great rivers may require bigger boats with sophisticated electronics, different sampling gear, and often special techniques (e.g., in studies of effects of fish and zebra mussels, we used this 110' long x 20' wide raft and field enclosures).**



**Raft with submerged potamocorrals drifting down Ohio River in zooplankton experiment**



**Permeable potamocorrals (right) and impermeable limnocorrals (left) next to St. Lawrence River**



# EMAP Design Considerations for Sampling Large & Great Rivers: Between River Differences

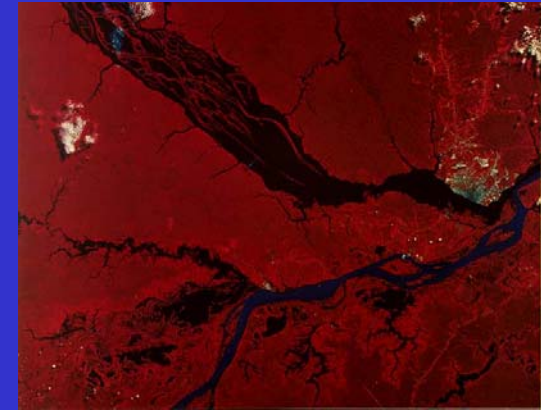
**a. channel morphology: e.g., constricted, braided, and constricted**



**Constricted Ohio River**



**Braided Tagliamento River in  
northern Italy**

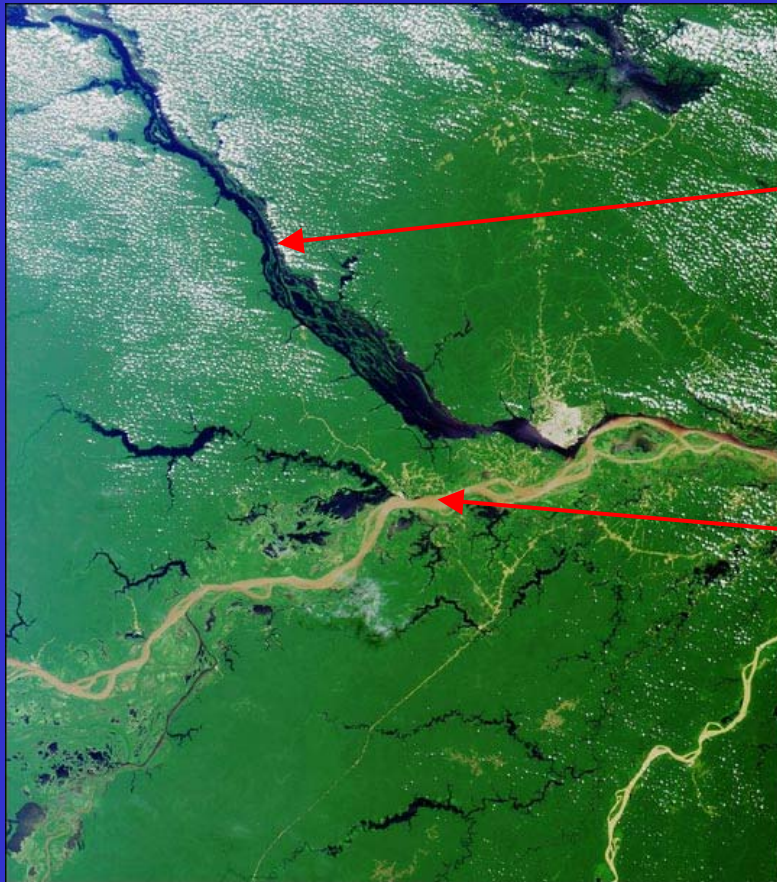


**Floodplain Amazon River  
(Landsat image)**



# EMAP Design Considerations for Sampling Large & Great Rivers: Among-River Differences

- a. channel morphology: floodplain, braided, constricted**
- b. natural turbidity**



**Low turbidity, blackwater  
Rio Negro (Amazon tributary)**

**Non-polluted but highly  
turbid Rio Solimoes**

# **EMAP Design Considerations for Sampling Large & Great Rivers:**

## **Among-River Differences**

- a. channel morphology: floodplain, braided, constricted**
- b. natural turbidity**
- c. annual hydrographic patterns**
  - timing of peak discharge**
  - length of high water stage**
  - periodicity and predictability of physical flood pulse**

# **EMAP Design Considerations for Sampling Large & Great Rivers:**

## **Between River Differences**

- a. channel morphology: floodplain, braided, constricted**
- b. natural turbidity**
- c. annual hydrographic patterns**
- d. unique characteristics of the biotic community**



# **EMAP Design Considerations for Sampling Large & Great Rivers:**

## **Between River Differences**

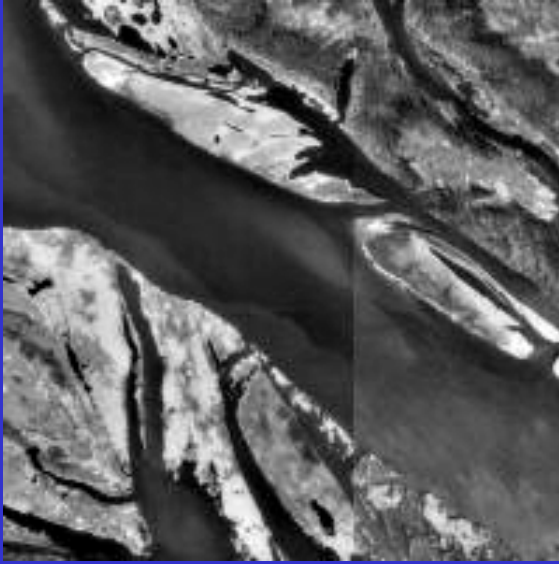
- a. channel morphology: floodplain, braided, constricted**
- b. natural turbidity**
- c. annual hydrographic patterns**
- d. unique characteristics of the biotic community**
- e. temporal variations over seasons and among years**

# EMAP Design Considerations for Sampling Large & Great Rivers: Between River Differences

- a. channel morphology: floodplain, braided, constricted
- b. natural turbidity
- c. annual hydrographic patterns
- d. unique characteristics of the biotic community
- e. temporal variations over seasons and among years
- f. macrohabitats
  - main channel vs slackwaters
  - benthic vs planktonic



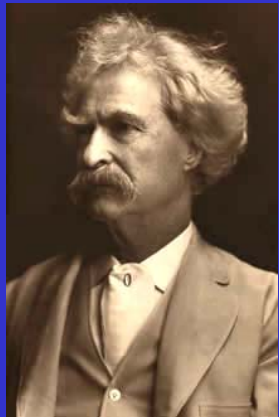
# EMAP Design Considerations for Sampling Large and Great Rivers: Anthropogenic Complications



braided reach of the  
Missouri River



channelized reach of the  
Missouri River



“A river without islands is like a woman without hair. She may be good and pure, but one doesn't fall in love with her very often.”

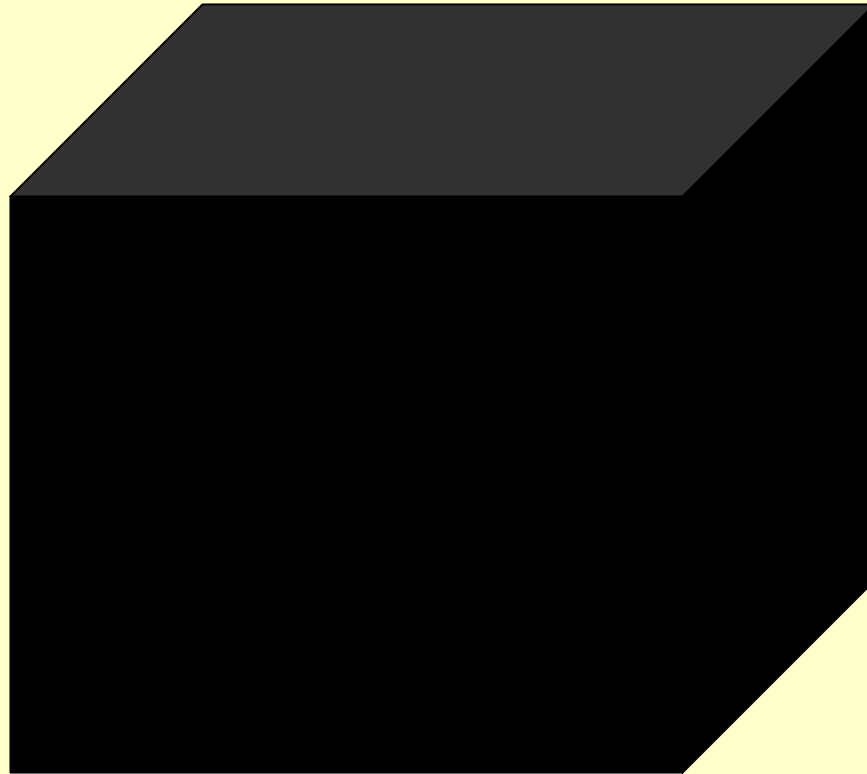
Samuel L. Clemens

- **Impoundments**
  - navigation (low head)
  - reservoirs (high dams)
- **Channelization**



## **Recall the goals of EMAP: develop tools to.....**

- Assess ecological condition of rivers**
- Forecast future risks to sustainability**



**Unfortunately, from the standpoint of understanding their functional ecology, large and great river ecosystems remain .....**

An aerial photograph of a river system, likely a delta or a large confluence, showing a complex network of channels and floodplains. The river channels are dark, winding lines that branch out across a landscape of red and green. The text overlays are positioned around the river, highlighting key ecological and management questions.

**River boundary definition**

**What aspects of ecosystem ecology do we need to know to manage great rivers for ecological integrity and sustainable use?**

**Role of slackwaters in biodiversity, primary and secondary production, food webs, and nutrient cycling**

**Critical food web pathways**

**Sources of energy fueling system metabolism and metazoan production**

# Energy Sources Fueling System Metabolism & Metazoan Production

**Critical to understand: ubiquitous influence and affected by river management**

**Several primary conceptual theories, including ....**

**Riverine productivity model (RCC; Vannote et al. 1980)**

**Flood pulse concept (FPC; Junk et al. 1989)**

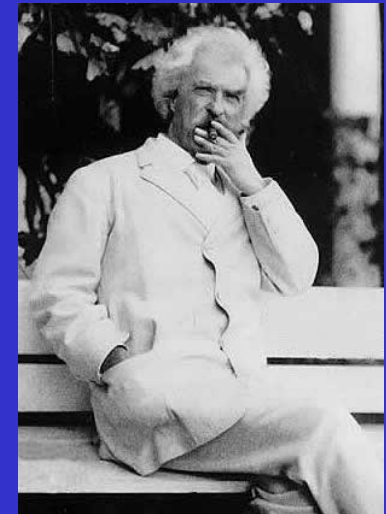
**Riverine productivity model (RPM; Thorp and Delong 1994, 2002)**



Photograph from Dr. Mike Settles

**Some truth and some conceptual “bull”  
in each of these theories.**

**Basing river management on any theory is risky at this point,  
and we certainly do not want to create any “sacred cows.”**



**“Sacred cows make the  
best hamburger”**

**Samuel L. Clemens**



# Take Home Message



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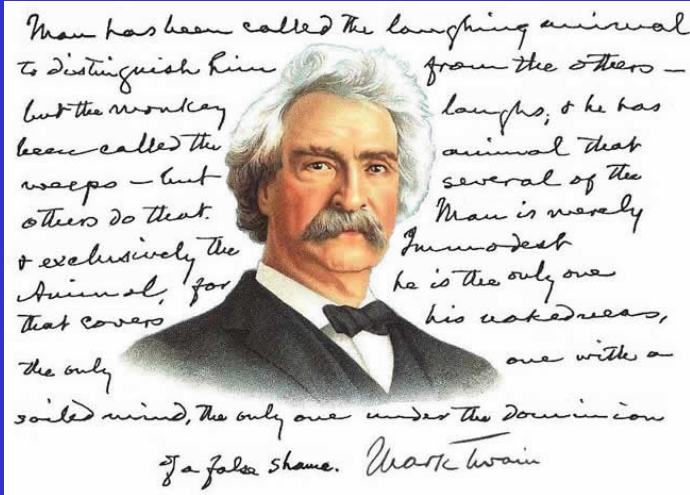


**An EMAP design for great rivers cannot be developed by simply scaling up from approaches used in wadeable streams.**

***Needed:* research on sustainability and workshops to define ecosystem integrity in great rivers.**

# Acknowledgments

(Contributors to this talk and people who keep me honest)



There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact.

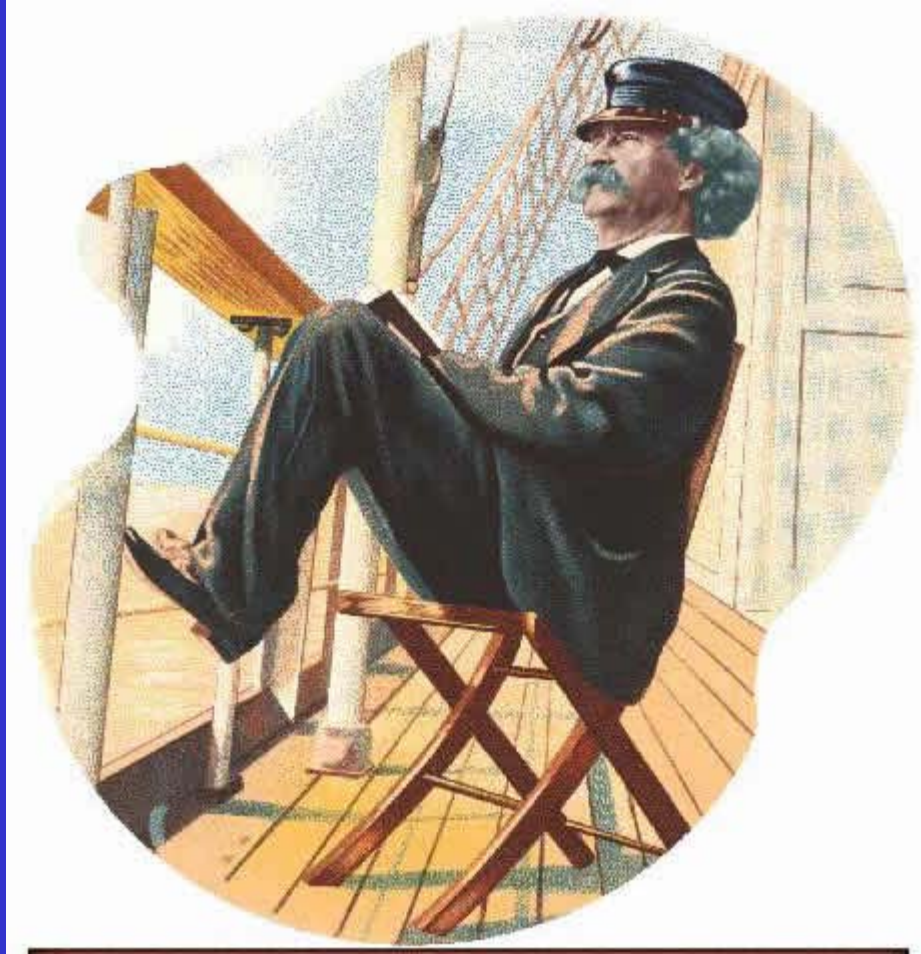
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If you start to thinkin' you're a person of some influence, try orderin' somebody else's dog around.

Cowboy Wisdom  
(and Mike Delong's)

**This guy !**



**“There are three kinds of lies ..... lies, damned lies, and statistics.”**

**Samuel L. Clemens**